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ABSTRACT

A study dealt with the use of the Position Analysis Questionnaire (PAQ) within a job component validity framework as the basis for estimating aptitude requirements of jobs represented by scores on commercially available tests as contrasted with scores on General Aptitude Test Battery (GATB) tests. Procedures generally consisted of the use of job dimension scores based on previous principal components analyses of the PAQ as the predictors of four types of test-related criteria, as follows: the mean test scores of incumbents on the individual jobs; the score one standard deviation below the mean of the incumbents on the individual jobs; validity coefficients; and an indication as to whether the test would be valid. Analyses were carried out for five constructs (general intelligence, verbal aptitude, numerical aptitude, spatial aptitude, and clerical perception) using all four criteria for those jobs for which adequate test data and PAQ analyses were available. In summary: (1) Previous research with the use of the PAQ as the basis for establishing aptitude requirements has dealt exclusively with test data from the GATB tests, but (2) the results of this study indicate clearly that such data can also be used in establishing aptitude requirements in terms of commercial tests that presumably measure the same constructs. (TA)

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Job-Derived Selection:

Follow Up Report

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study deals with the use of the Position Analysis Questionnaire (PAQ) as the basis for the estimation of aptitude requirements for jobs, the aptitudes in question representing five "constructs." The PAQ is a structured job analysis questionnaire that provides for the analysis of jobs of various types in terms of the relevance of each of 187 job elements that describe or imply basic human behaviors involved in jobs. The PAQ has been subjected to a series of principal components analyses resulting in the

identification of what are referred to as job dimensions. Scores on these job dimensions have been used in a series of studies as the basis for deriving estimates of the aptitude requirements of jobs expressed in terms of test-related data based on the nine tests of the General Aptitude Test Battery (GATB) of the United States Employment Service. The results of such investigations have indicated rather distinctly that the PAQ offers substantial potential as the basis for the estimation of aptitude requirements of jobs. The use of such a procedure (referred to as job component validity) would preclude the need for conventional test validation of tests in at least some circumstances.

This study dealt with the use of the PAQ within a job component validity framework as the basis for the estimation of aptitude requirements of jobs represented by scores on commercially-available tests as contrasted with scores on the GATB tests.

The general procedures involved first gathering available test normative and/or validity data for incumbents on various types of jobs, these test data being that for commercially-available tets that represented the constructs covered by five of the GATB tests. In addition, PAQ analyses were obtained for these jobs, either from the organizations from which the test data were obtained, or from corresponding jobs in other organizations for which PAQ analyses were available in the PAQ data bank.

The procedures generally consisted of the use of job dimension scores based on previous principal components analyses of the PAQ as the predictors of four types of test-related criteria, as follows: the mean test scores of incumbents on the individual jobs; the score one standard deviation below the mean of the incumbents on the individual jobs; validity coefficients; and an indication as to whether the test would be "valid."

Analyses were carried out for each of the five constructs using all four criteria for those jobs for which adequate test data and PAQ analyses were available.

A preliminary report (DeNisi, Shaw, and McCormick, 1976) reported on the results of such analyses for a sample of 96 jobs. This report followed the same basic procedures, but is based on data for a larger sample of jobs.

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INTRODUCTION

The identification of tests to be used in the selection of personnel for various jobs typically has been accomplished by traditional test validation procedures. These procedures are at best time consuming and costly, and sometimes cannot be carried out at all because of the limited number of job incumbents available for study or for other reasons. Because of these and other factors, there have been efforts over the years to develop generalized approaches for the establishment of test batteries for personnel selection that would preclude the need for validation of tests in each and every job situation. The notion of a generalized approach to the establishment of personnel test batteries was initially referred to by Lawshe (1952) as synthetic validity, and was later described by Balma (1959) as follows: "The inferring of validity in a specific situation from a logical analysis of jobs into their elements, a determination of the test validity for those elements, and a combining of elemental validities into a whole." Since the term synthetic validity has been critized as not being specifically appropriate for such a procedure, McCormick (1974) has suggested the use of the term job component validity.

Regardless of the term one uses to refer to this procedure, the basis of any such procedure is rooted in some type of systematic job analysis. In this regard, McCormick et al. (1972) indicate that the development of a procedure for establishing the job component validity of predictors for jobs would consist of the following: (1) some method of identifying the constituent components of jobs (which are referred to as job elements by Balma); (2) a method of determining, for an experimental sample of jobs, the human attribute(s) required for successful job performance as related to those job components; and (3) some method of combining the estimates of human attributes required for individual job components into an overall estimate of the human attribute requirements for an entire job. Such a procedure would make it possible to "build-up" the aptitude requirements for any given job by: (1) knowing what job components occur in the job in question, (2) knowing what aptitudes are required for each such component; and (3) having a procedure for summating the attribute requirements that are relevant to the individual job components.

The present research project is directed toward the further testing of a procedure for the establishment of the job component validity of tests that involves the use of the Position Analysis Questionnaire (PAQ). (The PAQ is a structured job analysis questionnaire that has been used as the basis for analyzing jobs for the purpose of establishing the job component validity of personnel tests.)

A preliminary report of this effort was prepared by DeNisi, Shaw, and McCormick (November 1976). That particular report summarized the results of the analyses of data for a sample of 96 jobs for which appropriate data were then available. This report is, in effect, a

follow up of that based on a larger sample of jobs for which relevant data have been obtained since the preparation of the preliminary report. In order that this report will be complete, certain background sections of the preliminary report will be included in this report as well.

Conventional Test Validation Procedures

To lend some background to the rationale for seeking some generalized approach to the establishment of test batteries for personnel selection, it would seem that a brief description of conventional test validation procedures should first be given. Such procedures need to be carried out for each particular job, preferably in the setting of the specific organization within which the job exists. Such procedures involve the following: (1) the administration of an experimental battery of tests to incumbents who are already on the job in question or to applicants who are going to be placed on the job; (2) the obtaining of some criterion measure of job performance for the individuals who have taken the tests; and (3) the analysis of the statistical relationships between the test scores and the criterion of job performance. Those tests for which a significant relationship is found between test scores and job performance criterion values can then be used for the selection of individuals for the job in question. As indicated in step 1 of the above procedure, there are actually two variations of the general test validation methodology. One of these is a concurrent procedure, which involves the use of a sample of individuals actually on the job. The other method, which is referred to as predictive validity, consists of the administration of the tests to candidates for the job, and the later analysis of the relationship between test scores and the criterion of job performance after the individuals have had sufficient time to be able to demonstrate their job-performance abilities. (In the case of predictive validity, the test is not used in the actual selection of the job candidates used in the validation procedure.)

Because of the time required to carry out these procedures, and because such procedures cannot be carried out in some circumstances because of small samples or for other reasons, there is a fairly obvious need for a "generalized" validation procedure.

The Position Analysis Questionnaire (PAQ)

Various procedures have been used in the development of some type of job component or generalized validity procedure. One of these has involved the use of the Position Analysis Questionnaire (PAQ). The PAQ is a structured job analysis questionnaire that provides for the analysis of individual jobs in terms of 187 job elements. In the analysis of jobs with the PAQ job elements, various rating scales are used (the particular rating scale used for each job element being the one for which the concept of the scale seems particularly appropriate to the element). Most of the scales are six-point scales, ranging from zero (does not apply) to five (the highest value). The various scales used include those dealing with importance, time, extent of use, and in some instances special scales. In certain instances a dichotomous scale is used. The dichotomous scale provides for indicating whether the job element in question does, or does not, apply to the job.

Data based on the PAQ have been subjected to various principal components analyses. Two earlier analyses were carried out by Jeanneret and McCormick (1969) and Marquardt and McCormick (June 1974). A more recent one has been carried out by Mecham (1977). The basic pattern of these analyses has been substantially the same. In the first place, separate principal components analyses were carried out with the job elements within each of the six divisions of the PAQ, and in the second place, an overall analysis was carried out with most of the job elements of the PAQ included in the same analysis. The principal components resulting from these have generally been referred to as job dimensions. The most recent analyses by Mecham, based on a sample of 2200 jobs, probably represents the most adequate set of job dimensions, primarily because of the fact that the sample of jobs included in the analysis was somewhat more representative of jobs in the labor force than either of the previous analyses. Therefore the results of Mecham's analysis will be used in this study.

The analyses by Mecham resulted in 32 job dimensions as based on the principal components analyses of the job elements within the six divisions, and 13 job dimensions based on an overall analysis. These are listed in the appendix.

Use of the PAQ to establish job component validity. One of the primary uses of the PAQ has been in the framework of establishing the job component validity of tests for various jobs. This has consisted primarily of the analysis of samples of jobs for which test data for the job incumbents were available from the United States Employment Service (USES), and for which PAQ analyses were available. The USES publishes test data for incumbents on several hundred jobs, the test data consisting of normative and validity data for the nine tests of the General Aptitude Test Battery (GATB). These tests are as follows:

G - Intelligence
V - Verbal Aptitude
N - Numerical Aptitude
S - Spatial Aptitude
P - Form Perception
Q - Clerical Perception
K - Motor Coordination
F - Finger Dexterity
M - Manual Dexterity

As the primary approach to the use of PAQ-based data in the job component validity framework, samples of jobs were selected which "matched" the ones for which the USES has published test normative and/or validity data. In these analyses, the primary criterion of the "importance" of a given test to any given job consisted of the mean GATB test scores of the incumbents on the individual jobs. This criterion was based on the assumption that individuals tend to "gravitate" into jobs which are commensurate with their own abilities. Thus, it would be assumed that jobs for which the incumbents have high mean test scores

on a given test would require more of the quality measured by the test than jobs for which the incumbents have lower mean test scores. Using mean test scores as a criterion of the "importance" to individual jobs of the attributes measured by the various tests, the scores on the PAQ job dimensions were then used in a regression procedure for the prediction of the mean GATB test scores.

A second criterion of the importance of the attributes measured by the individual tests to the jobs in the sample consisted of the validity coefficients reported by the USES.

Two studies involving the use of these two criteria have been carried out. The first of these, by Mecham and McCormick (1969), involved a sample of PAQ analyses for 179 positions which "matched" 90 jobs for which the USES published test data. In this instance the PAQ job dimensions that were used as predictors were those developed by Jeanneret and McCormick (1969). In the second study PAQ analyses for 659 positions were matched with 141 jobs for which the USES had published test data (Marquardt and McCormick, July 1974). In the case of both of these studies the prediction of the mean test scores of the incumbents from PAQ job dimension scores was quite respectable. However, the prediction of the validity coefficient criterion was not as good, perhaps at least partially because of the well-recognized problems associated with validity coefficients such as poor criteria, restricted range, etc. The ranges and medians of the multiple correlations across the nine GATB tests resulting from these studies are given below.

Criterion		Mecham and McCormick	Marquardt and McCormick
Mean test scores			
	Range	.59 to .80	.46 to .76
	Median	.71	.73
Validity coefficients			
	Range	40 to 55	26 to 44
	Median	.47	.39

In the third analysis of this type carried out by Mecham (1977), data relating to the PAQ analyses were matched with 163 jobs for which the USES had published test data. In this study, however, instead of matching individual PAQ analyses with these 163 jobs, all of the PAQ analyses that had 9-digit code numbers from the Dictionary of Occupational Titles (DOT) were "averaged" to represent a "single" PAQ analyses to be matched with each of the 163 jobs for which the GATB test data were available. This procedure was used since it was felt that the "average" PAQ job dimension scores for various jobs with the same DOT code number represent more stable values for the jobs than individual PAQ analyses.

In that study both sets of job dimension scores were used as predictors of the criteria of mean test scores and validity coefficients. Since the division job dimensions generally resulted in better prediction than the overall dimensions, only the division job dimensions were used in the study covered by this report.

In addition to the criteria of mean test scores and validity coefficients used by Mecham, however, another criterion of the "importance" of various

tests to the jobs in question was used. This criterion was the value one standard deviation below the mean of test scores of the incumbents on the individual jobs. This criterion might be viewed as a "potential/cutoff score." Although test cutoff scores used in personnel selection obviously vary with the labor market conditions, it is probable that, in general terms, scores one standard deviation below the mean would more nearly approximate typical cutoff scores than mean scores as such. This criterion is referred to as "1SD below the mean."

The primary results of Mecham's analyses are presented on the following page of this report, since they are not yet available in publications.

In all three studies dealing with the prediction of GATB test-score criterion values from PAQ job dimension scores, the predictions of the cognitive tests were best, those of the perceptual tests were intermediate, and those of the psychomotor tests were the lowest. Although there were differences in the predictions for the various types of tests, the general level of predictions was viewed as demonstrating the potential utility of such procedures for the identification of tests for use in personnel selection. It should be noted that the predictions based on Mecham's job dimensions were slightly better than those based on the dimensions from the two previous studies.

OBJECTIVES OF THE PRESENT STUDY

The use of PAQ job dimension scores for the prediction of mean GATB test scores of "hypothetical" samples of job incumbents on various jobs clearly can give some indications of the aptitudes that presumably would be required for individual jobs. However, since the predictions are in terms of GATB test scores, and since the GATB tests are not available for use by private organizations, the operational use of such predictions would necessitate that the predictions in terms of the nine GATB tests would have to be "converted" into terms corresponding to those of commercially-available tests. Thus, it would be desirable to develop some procedure for use of the GATB test score predictions as the basis for the selection of corresponding commercially-available tests, and for the estimation of scores for such tests which correspond to those of the GATB tests. Thus one could use predictions of appropriate GATB test score cutoffs as the basis for deriving estimates of cutoff scores on other (corresponding) tests which would be comparable to those of the GATB test in question. The basic objective of the present study has been that of developing some procedure for shifting from the prediction of GATB test scores to the prediction of scores on commercially-available tests that presumably correspond with those of the several GATB tests.

There are two possible general approaches to the "matching" of GATB and commercially-available tests that might serve as the basis for converting from one to another. The preferable approach would be one for which data are available for two tests that are based on the scores of the individuals in a "general population" who have taken both tests. The equivalence of two such tests would best be reflected

Shrunken Multiple Correlations of Combinations of
PAQ Division Job Dimension Scores
as Predictors of GATB Test-related Criteria

Number of Jobs = 163

GATB test	Criterion		
	Mean test scores	1 SD below the mean	Validity coefficients
G: Intelligence	.79	.78	.23
V: Verbal aptitude	.83	.84	.06
N: Numerical aptitude	.77	.73	.08
S: Spatial aptitude	.69	.71	.24
P: Form perception	.61	.60	.13
Q: Clerical perception	.78	.75	-.02
K: Motor coordination	.73	.67	-.04
F: Finger dexterity	.41	.41	.15
M: Manual dexterity	.30	.24	.39
Median	.73	.71	.13

by a high correlation between the two. In turn, corresponding norms for the two tests preferably should be available for the general population, in order to make it possible to "convert" scores from one test to equivalent scores on another test in terms of either standard deviation units from the mean, or in terms of percentile norms. The USES has published data on certain commercial tests that have been administered to the same samples of individuals who have taken certain of the GATB tests. These data, however, were found not to be particularly useful for this study, since many of the tests for which such data were presented were those more typically used in educational circumstances rather than for personnel selection. Also many of the samples of individuals represented in the normative data consisted of students or of individuals on given occupations rather than of the "general population." In most instances normative data were simply not available.

The second approach is one in which a judgment needs to be made about the equivalence of test content, that is, the equivalence of the "construct" that presumably is being measured by the two tests in question. This is admittedly a subjective evaluation, and therefore needs to be approached with caution. In the case of some pairs of tests there is no particular problem in making a reasonably valid judgment about their equivalence, but in the case of other tests the subjective judgment may not be entirely valid. In those instances where tests are considered to be equivalent, there is of course the further possible problem of conversion of norms from one test to those for the second test. Many of the norms presented in test manuals are for individuals on certain jobs or in various job groupings, without there being norms available for what might be viewed as a "general" population. (It might be added that the norms for the GATB tests have been based on a sample of 4000 individuals whose jobs are reasonably representative of the major occupational groups of workers in the labor market. Therefore, the application of this approach preferably would require the availability of a reasonably comparable set of norms for any other test that would be considered as being essentially "equivalent" to one of the GATB tests.)

METHOD

The primary focus of this study, then, was to develop some way of testing the utility of a job-component validity model, based on PAQ job dimensions, for use with commercially-available tests. To accomplish this it would be necessary to translate the predictions for the GATB tests made by combining the PAQ job dimension scores into terms relevant to commercially-available tests representing similar aptitude constructs. Therefore, this study was viewed as a test of the generalizability of the PAQ-based job-component validity model that has been heretofore tested only with GATB test data.

Sources Of Data

The basic approach used has been that of obtaining, from various organizations, data from any validity studies that they had carried out for jobs in their organizations; as well as obtaining PAQ analyses for any

such jobs. Several approaches were used in an attempt to obtain such data, including the following:

1. Direct mailing of letters to several hundred organizations, explaining the goals of the project and asking them to submit any relevant test data they had available (validity information as well as normative data), and asking them to arrange for the analysis of jobs in question with the PAQ.

2. Establishing contacts with various test publishing firms, asking them if they had any validity or normative data on any of the tests which they published for incumbents on specific jobs.

3. Mailings to consulting firms which it was believed were involved in test validation studies.

4. Mailings to former graduate students of Purdue University.

5. Appeals made in certain publications which it was felt had the audiences that it might be useful to contact, asking if anyone had the kinds of data we were seeking. These appeals included articles in The Industrial Psychologist (TIP) (the newsletter of the Division of Industrial/Organizational Psychology of the American Psychological Association), and the Personnel Administrator, which is the official organ of the American Society for Personnel Administration.

Although these several approaches were used, the number of jobs for which test data and PAQ analyses were obtained was disappointing by small. In the case of certain jobs for which test data were available the organization or individual furnishing the test data was unable or unwilling to arrange for the analysis of those jobs with the PAQ. In order to include these jobs in our sample, it was decided to "match" these jobs with jobs which had already been analyzed with the PAQ and which were in the PAQ data bank (presently consisting of analyses for some 25,000 positions). This matching was carried out on the basis of job code numbers from the Dictionary of Occupational Titles (DOT). Where possible this matching was based on the 9-digit code numbers of the DOT. This matching resulted in the addition of 30 jobs.

In an attempt to enlarge the sample of jobs, some archival data were used. Such data consisted mainly of validity or normative data for various tests for incumbents on different jobs as reported in sources such as the Validity Information Exchange of Personnel Psychology, The Handbook of Employee Selection (Dorcus and Jones, 1950), and the manuals for various tests commonly used in industry. The PAQ analyses for the jobs for which data were obtained through these sources had to be obtained by matching these jobs with jobs in the PAQ data bank. As before, this was done on the basis of DOT code numbers. This archival source yielded data on an additional 62 jobs, bringing the total sample of jobs up to 202.

Constructs Used in the Study

As was mentioned above, this study required relating data on a number of commercially-available tests to the GATB tests. This presented a bit of a problem in that the factorial composition of apparently "similar" tests is sometimes quite different, and thus two tests of, for example, verbal ability, may actually be testing somewhat different abilities or attributes. Recognizing this problem, it was nonetheless decided that the only feasible way that this study could be carried out would be to consider, as measures of the same "construct," all of the commercially-available tests that purport to measure the same construct as that represented by any given GATB test. Although the actual GATB tests were not available, there is information published concerning the general nature of each subtest. Thus, for example, a test of "verbal aptitude" that consisted primarily of reading comprehension items would not be included as a test of the "Verbal Aptitude" construct as measured by the verbal (V) GATB test used in this study to represent that construct.

Since the entire framework of this study revolved around the GATB, it was only natural that the constructs which would be of interest would be the nine measured by the subtests of the GATB, these being General Intelligence (G), Verbal Aptitude (V), Numerical Aptitude (N), Spatial Aptitude (S), Form Perception (P), Clerical Perception (Q), Motor Coordination (K), Finger Dexterity (F), and Manual Dexterity (M). The commercially-available tests used to measure each construct are given in the appendix, along with other publishers.

Development of Equivalent Norms for Tests

Once the individual tests has been classified as measuring a specific construct, it was then necessary to develop a method of equating scores on each of the commercially-available tests used to measure the construct to test scores on the GATB subtests for that same construct. The optimal procedure for accomplishing this would have been to have available normative test data for a single, general working population on all the tests within a particular construct. Such data were not available, however, and other methods had to be employed. These methods involved the combining and synthesizing of general norm groups, and eventually all test scores were expressed in the same standard score units, those units based on the standard score distribution reported for the GATB tests. The GATB standard scores are based on a mean of 100 and a standard deviation of 20. A more detailed explanation of the methods employed to develop these equivalent norms is given in the appendix.

As a result, for any construct, it was possible to locate, for each job for which test data for a test measuring that construct were available, the position on the continuum of scores on the construct where the sample of incumbents on that job would fall. It was the scores of these incumbents on the different constructs that were used as criterion values of mean test scores and of "1SD below the mean" in this study, such criterion values for various jobs being viewed as reflecting the relative "importance" to the jobs in question of the construct in question.

Actual Criteria Used

As indicated above, four criteria as related to individual jobs were used in various phases of the study, these being considered as reflecting various indices of the "importance" to the individual jobs of each of the nine constructs as represented by the GATB tests. These criteria for each job and for each test, consisted of: (1) mean test score of the job incumbents on the individual job; (2) the test score one standard deviation below the mean of the scores of incumbents in each job, referred to as "1SD below the mean;" (3) a coefficient validity; and (4) an indication of whether the test would be "valid" for the job. The first two of these were considered to be the primary criteria used in the study. Considering for a moment the criterion of mean test scores of incumbents on the individual jobs, one could view a continuum for each of the nine constructs expressed in standard score form with the mean scores of incumbents on the various jobs falling in various positions along that continuum, from low to high. (As indicated earlier, the conversion of the norms of the commercially-available tests to the standard score forms of the GATB tests served as the common metric for relating the mean scores of incumbents on that continuum.) "1SD below the mean" might be viewed as a "potential" cut-off score.

In the case of the criterion of validity coefficients it was of course not necessary to be concerned about the "normative" data that were used with the criteria of mean test scores and "1SD below the mean." Rather, for any given construct, the coefficients of validity of the tests which were considered to represent that construct could be viewed as representing a continuum from low to high as expressed by the actual coefficient values themselves. In the case of certain analyses the fourth criterion was used, namely an indication as to whether individual tests would be "valid" predictors of performance. This criterion was based on the question as to whether the initial coefficient of validity for that test itself was one which was statistically significant or not. (See the discussion in the next section.)

Development of Predicted Criterion Values

Two basic types of predicted criterion values were used in the study. One of these was based on job dimension scores, and the other involved the use of "attribute-based" data.

Predicted criterion values based on job dimension scores. In the use of job dimension scores for deriving predicted criterion scores, the predicted values for the individual jobs were derived from a standard computer printout of data that is printed from the PAQ analysis of any given job. These computer printouts are based on previous analyses of PAQ-based data as related to the published USES test data mentioned

previously. Such data include, for each of the sample jobs, and, for each GATB test, estimates of the mean test score of job incumbents, the "1SD below the mean," and the validity coefficient. The computer printout, based on regression analyses of PAQ job dimension scores as related to these three values, provides estimates, for any given job, of the first three criteria. In connection with the fourth criterion the computer program on which these computer printouts are based also includes provision for making a prediction about those tests (usually three) which would be valid predictors for performance on the job in question. This particular aspect of the program, in effect, is a "policy capturing" procedure that parallels the practice of the USES in its approach to the identification of the three "best" or most "valid" tests for use in the selection of individuals for any given job, and in establishing cut off scores for those three tests. The PAQ printout, in effect, provides estimates of the cutoff scores of those three tests. Thus, for any given job, the fourth criterion consists of the indentification of three tests which are predicted to be the most "valid" for use in selecting people for any given job, based on USES practices in this area. In practice, a prediction was made from the PAQ as to whether each test would or would not be one of the three "valid" predictors. Each such prediction was then compared with the actual criterion data in terms of whether the test was or was not "valid."

Predicted criterion values involving "attribute-based" data. The use of the "attribute-based" data for deriving predicted criterion values was predicated on the rated "attribute requirements" of the PAQ elements (Marquardt, 1972; and Mecham, 1968). Such ratings were made by psychologists on each of 49 "aptitudinal" attributes and 27 "situational" attributes that were considered to be potentially relevant to the world of work. (The situational attributes consist of descriptions of work situations to which job incumbents presumably have to "adjust," such as "varied duties," "dealing with people," and "working alone." They are considered to have implications in terms of personality, temperament, and interest factors.) The median ratings on these attributes for any given job element comprise the "attribute profile" for that element. Previous studies (Mecham, 1970; Marquardt, 1974; and Shaw and McCormick, 1976) have shown that the use of "attribute-based" data has potential for serving as the basis for "building up" estimates of the total aptitude requirements for jobs for at least certain types of aptitudes.

Mecham (1970) and Shaw and McCormick (1976) used two methods of combining attribute-based data for building up these estimates of aptitude requirements. The first of these involved the use of a combination of PAQ job analysis ratings on individual jobs and of the attribute ratings on individual job elements. The second method involved the use of "attribute dimension scores" based on a combination of PAQ job analysis ratings on individual jobs and individual attribute ratings for the job elements. Since these two studies revealed relatively little practical difference between these two procedures, the present study utilized the first procedure only.

The procedure for arriving at estimates of the attribute requirements for each of the 202 jobs in the present sample is shown below:

Illustration of Method of Deriving Estimates of Attribute Requirements of Jobs Based on Attribute Ratings of Job Elements of the PAQ

Hypothetical job analysis ratings on 5 PAQ job elements for job x		Median attribute ratings for job elements of the PAQ				Cross-product matrix resulting from job analysis ratings x attribute ratings			
		Attribute				Attribute			
Element	Rating	1	2	3...	71	1	2	3...	71
1	2	5	0	3	1	10	0	6	2
2	3	2	1	4	1	6	3	12	3
3	5	1	0	5	0	5	0	25	0
4	0	5	4	0	2	0	0	0	0
5	5	3	5	2	1	15	25	10	5
	Estimate of attribute requirements					36	28	53	10

For each job, a column vector consisting of the PAQ job analysis ratings for that job was multiplied across each column of the attribute matrix consisting of the median ratings of the various attributes for the PAQ job elements. Each column of the resulting cross-product matrix was then summed. This sum represents an estimate of the degree to which the attribute in question was predicted as being necessary for performance on the job in question. This procedure was carried out for each job in the sample, thus yielding for each job an estimated attribute requirement for each of the 71 attributes.

Relating Predicted to Actual Criterion Values

Criterion values based on job dimension scores. In the use of the job dimension scores as predicted criterion values, a distinction was made for each construct represented by the GATB tests between job dimension scores for individual jobs and those for "job families" to which individual jobs were "assigned." In the case of the predictions to be made on the basis of PAQs for individual jobs, the predictions of the four different criteria used in the study were derived from the conventional PAQ computer printouts for the individual jobs.

As reported in Shaw, DeNisi, and McCormick (1977) three "sets" of job families were used in the present study. These three sets had been formed by developing a set of clusters at the points in the interative process involved in the cluster analysis at which the individual jobs in the sample had been clustered into 60, 40, and 20 job families (3 sets of clusters with 60, 40 and 20 clusters respectively).

In the case of the predictions based on job family data, each individual job was allocated to the job family with which it was most closely affiliated. This was done on the basis of a D^2 index of relationship between individual jobs and the "average" job dimension scores of those jobs which had been previously used in the cluster analysis of the PAQ data, and which formed the different job families.

This matching process was carried out for each of the three different sets of job families. Once the individual jobs in the sample had been matched with the appropriate job family in each of the sets of families, the "average" job dimension score of each job family was computed, and was then used to predict the actual criterion values of the jobs within that family just as if it was a PAQ analysis for an individual job.

In the case of the predictions based on individual PAQ analyses, as well as those based on job family data, there was of course the initial "selection" of jobs for which relevant test data were available for the incumbents as related to any given construct. In addition, given those jobs for which test data for a given construct were available, there was a further selection, for individual analyses, of the types of test criterion data which were actually available. Thus, for any given construct, a job would be included in the analysis for any particular criterion, depending upon whether actual criterion data were available such as mean test scores, validity coefficients, or an indication as to whether a coefficient was or was not valid. Thus, the analyses consisted of a series of sub-analyses for the individual constructs, each sub-analysis consisting of data for jobs for which both predicted and actual criterion data were available.

In this process the actual (or obtained) test values for incumbents on any job were converted to standard scores on the constructs involved. The predicted scores were all in terms of GATB tests, but, since the constructs were defined in terms of the GATB tests, and since all scores were in a common metric, this provided no problem. The actual predicted scores themselves were the result of combining the PAQ job dimension scores for any job, according to regression equations developed in earlier research designed to predict GATB test scores from PAQ job dimension scores (Mecham, 1977). These equations were designed to yield mean test scores, the "1SD below the mean" criterion values, and validity coefficients, as well as to make some prediction about which tests should be valid predictors of performance for a job. These predictions were then compared to the actual criterion data in these areas by means of a series of correlational analyses.

Criterion values involving "attribute-based" data. In the use of the attribute-based data the data relating to any given construct involved those jobs for which relevant test data were available. In each of these analyses the mean test score criterion and the 1SD below the mean criterion were used.

The predicted criterion values involving attribute-based data were then correlated with the actual criterion values in the same manner as used with the predicted criterion values based on job dimension scores.

General Analyses with Sample Jobs

With this final sample of 202 jobs for which there were available test data from either an organization or various archival sources, as well as a PAQ analysis for each job, the following operations were carried out:

1. The commercially-available tests for which data were now available had to be matched to individual GATB tests which were judged to measure the same "constructs."

2. A method had to be developed which would allow the equating of the norms for the commercially-available tests with the norms of the corresponding GATB tests.

3. Analyses would be carried out relating the PAQ predicted GATB test data to the data on the commercially-available tests in question. In various phases of the study this comparison would revolve around all or some of the following four criteria: (1) the mean test scores; (2) the criterion "1SD below the mean;" (3) validity coefficients; and (4) the determination of whether or not the test would be a "valid" predictor of performance for the job in question.

The total sample then consisted of data for 202 jobs.

The sources of data for the individual jobs are given in the Appendix, along with an indication of the tests for which test data for incumbents on the individual jobs were available.

Basis of Prediction

	Individual Jobs		Job Families	
Criterion	Job Dimension Scores	Attribute Data	Job Dimension Scores	Attribute Data
MEAN	X	X	X	
"1SD BELOW"	X	X	X	Not Relevant
VALIDITY	X	—	X	
VALID-NON VALID	X	—	X	

An "X" indicates those specific analyses that were carried out.

RESULTS

There were actually several sets of analyses which served to replicate, and somewhat expand the planned analyses outlined earlier; all will be reported. The results will be divided into two sections, one for the analyses based on job dimension scores and one for the analyses based on the attribute profile data.

Analyses Based on Job Dimension Scores

The results of the correlations between predicted and obtained scores on all four criterion indices for the entire sample of 202 jobs are reported in Table 1. The results for predictions based on the individual PAQs as well as on the data for 20, 40 and 60 clusters are also given. As can be seen in Table 1, the predictions based on the individual PAQs regarding mean test scores are reasonably satisfactory. All five correlations are significant (four of them beyond the .001 level) and they range from .35 (Spatial Aptitude) to .71 (Verbal Aptitude). The results for the three sets of cluster predictions generally follow the same pattern as for the individual PAQ predictions (i.e., the correlation for Spatial Aptitude is the smallest, and that for Verbal Aptitude is the largest). However, the correlations based on the cluster data are generally lower than those based on individual PAQ analyses, especially for General Intelligence and Spatial Aptitude.

The results obtained for the scores "1 SD below the mean" are similar to those for the mean test scores. All five correlations are significant (four of them beyond the .001 level) and they range from .43 (Spatial Aptitude) to .71 (Verbal Aptitude). An exception to this pattern is that the correlations for Clerical Perception increased from .38 for the mean test score to .60 for the value 1 SD below the mean. The sample sizes on which these correlations were based were different, being 37 and 15 respectively. However, both correlations are significant at the .05 level. Again, the cluster based predictions follow the same pattern as obtained with the individual PAQs except that they are generally somewhat lower, especially the correlations for General Intelligence (although to a lesser extent for the 20 cluster predictions) and Spatial Aptitude.

It might be, however, that the results for the prediction of mean test scores and the scores 1 SD below the mean were not really comparable because of differences in the samples for these two analyses. It was therefore decided to carry out a similar analysis for only those jobs for which data on <u>both</u> criterion indices were available. The results for prediction of both mean scores and scores 1 SD below the mean on this "matched sample" are also given in Table 1. In this analysis all five correlations for both criterion indices are also significant, but the correlations are generally higher than for the "complete" sample. Further, the correlations for these two criteria are closer together for the individual criteria than in the case of the "complete" sample.

Table 1

Correlations Between Predicted and Actual Test-related Criteria for Five Constructs: Total Sample

Criteria and Constructs	Individual PAQs	Cluster-based predictions 20 Clusters	40 Clusters	60 Clusters	N
Mean Test Scores: Complete Sample[1]					
General Intelligence	.51***	.15	.09	.13	111
Verbal Aptitude	.71***	.65***	.67***	.70***	50
Numerical Aptitude	.40***	.39***	.46***	.44***	162
Spatial Aptitude	.35***	-.13	-.08	.07	123
Clerical Perception	.38*	.46***	.44**	.50***	37
1 SD Below Mean: Complete Sample[1]					
General Intelligence	.46***	.22*	.11	.15	110
Verbal Aptitude	.71***	.62***	.68***	.60***	50
Numerical Aptitude	.44***	.36***	.46***	.43***	141
Spatial Aptitude	.43***	-.01	.03	.01	102
Clerical Perception	.60*	.42	.44	.39	15
Mean Test Scores-Matched Sample[2]					
General Intelligence	.50***	.13	.05	.12	110
Verbal Aptitude	.71***	.65***	.67***	.60***	50
Numerical Aptitude	.43***	.41***	.50***	.47***	141
Spatial Aptitude	.40***	-.13	-.10	-.13	99
Clerical Perception	.53*	.44	.37	.37	15
1 SD Below Mean-Matched Sample[2]					
General Intelligence	.46***	.22*	.11	.15	110
Verbal Aptitude	.71***	.62***	.68***	.60***	50
Numerical Aptitude	.44***	.36***	.46***	.43***	141
Spatial Aptitude	.43***	.01	.06	.04	99
Clerical Perception	.60*	.42	.44	.39	15
Validity Coefficients					
General Intelligence	-.54	.37	-.14	-.14	13
Verbal Aptitude	.30	.53***	.58***	.28	36
Numerical Aptitude	.23*	.12	.47***	.40***	76
Spatial Aptitude	.26	.29	.25	.35*	43
Clerical Perception	-.02	-.03	.16	.32*	29
Valid-NonValid					
General Intelligence	.17	-[3]	-	-	13
Verbal Aptitude	-.18	-	-	-	36
Numerical Aptitude	.19	-	-	-	76
Spatial Aptitude	.76***	-	-	-	43
Clerical Perception	.51**	-	-	-	29

Table 1 (Cont.)

[1]The "complete sample" represented by this table includes all jobs for which mean test score data were available.

[2]For these analyses, only jobs for which data were available on both mean test scores and scores "1 SD below mean" were used. This was done to eliminate any differences between the results for these two criterion indices due only to different samples.

[3]There were no analyses conducted on the "Valid-NonValid" criterion for the clusters.

*Significant, $p < .05$
**Significant, $p < .01$
***Significant, $p < .001$

The results for the two criterion indices dealing with validity coefficients (the coefficient itself and the valid-nonvalid criterion) are disappointing (As indicated before, however, previous analyses with the criterion of validity coefficients have also resulted in limited predictions.) For the predictions based on the individual PAQs only one correlation predicting validity coefficients was significant (Numerical Aptitude) and two were actually in the negative direction, the range going from -.54 (General Intelligence) to .30 (Verbal Aptitude). The results for the valid-nonvalid criterion were only slightly better, with two of the correlations being significant, the range going from -.18 (Verbal Aptitude) to .76 (Spatial Aptitude). Although there were no cluster based predictions of the valid-nonvalid criterion, the predictions of validity coefficients for the clusters produced rather interesting results. The correlations tend to be higher for the cluster-based predictions than for the predictions based on individual PAQ analyses; also there are relatively more significant correlations for the cluster based predictions.It is likely that, by averaging PAQ profiles within clusters, some of the error variance due to the generally low predictive ability of PAQ data relative to validity coefficients, has been eliminated, thus resulting in higher correlations when jobs are assigned to clusters.

Although these results are reasonably respectable, there was one portion of the sample that presented problems. Data for 79 jobs were from one organization (hereafter referred to as "Company X") and all test data from this company were based on "special" or in-house tests (see Appendix A). Furthermore, the test data received from that organization were available in terms of only seven clusters of jobs. In the present study each of these 79 jobs was treated as an individual job. Therefore for the jobs in one job family from Company X there were as many sets of predictions as there were jobs in the group, but only one set of criterion test data. This fact was seen as a potentially contaminating factor in the analyses, and it was decided to conduct an additional series of analyses eliminating those jobs from Company X. This reduced the size of the total sample to 123 and the results obtained with this smaller sample are given in Table 2.

As can be seen in Table 2, the results with this smaller sample are generally better than those obtained with the total sample of 202 jobs. The predictions of mean test scores still produce five significant correlations for the individual PAQ predictions, the range now being from .30 (Spatial Aptitude, the only prediction to suffer in the smaller sample) to .74 (General Intelligence). The more marked improvement, however, comes with the three sets of cluster based predictions. Although the correlations are still somewhat lower than those obtained with the predictions based on individual PAQ analyses, now, for each set of clusters, at least four of the correlations are significant.

The results for the criterion of scores 1 SD below the mean show even more improvement. Again all five correlations are significant, but the range of these is higher, being from .60 (Clerical Perception)

to .71 (Verbal Aptitude). Also, for each set of cluster based predictions, in this analysis four of the correlations are significant; (the correlations for predictions of Clerical Perception are not significant for any cluster). In addition the magnitudes of these cluster based correlations are much closer to those obtained with the individual PAQs.

Since in the case of the criteria of mean test scores and of scores 1 SD below the mean there were different numbers of jobs included in the analyses for most of the constructs, some of the differences in the results with these two criteria might be due in part to differences in the samples, as in the case of the jobs in the total sample of 202 as presented in Table 1. Therefore, in order to make possible a clearer comparison of predictions with these two criteria, additional analyses were carried out for those jobs for which data on both of these criteria were available, there being 93 such jobs. The results for these "matched" samples are also given in Table 2. These results probably are most representative of the relative predicability of PAQ-based data for the criteria of mean test scores and scores 1 SD below the mean, since they are based on the same identical sample of jobs, and since the potentially contaminating influence of the jobs from Company X has been eliminated. These results, also presented in Table 2, are quite respectable. All five correlations for the mean test scores are significant and they range from .53 (Clerical Perception) to .74 (General Intelligence and Spatial Aptitude). The cluster based predictions for mean test scores are also quite good with four of five correlations being significant for each set of clusters. Again, predictions of Clerical Ability were poorer for the clusters. The results for the prediction of the criterion of scores 1 SD below the mean are essentially the same here as for the complete sample (that is the sample before matching) and are also quite good. These results with this matched sample definitely provide support for the use of a PAQ-based job component validity model for the identification of aptitude tests for use in personnel selection.

The results for the prediction of validity data are not substantially different from those obtained with the larger sample discussed earlier. Once again the majority of correlations are rather disappointing. It will be noted in Table 2, however, that the clusters seem to do a somewhat better job of predicting validity coefficients and the valid-nonvalid criterion than do the individual PAQs.

As a further analysis, it was decided to derive some "overall" index of the predictive ability of the individual PAQs and of the cluster based predictions. This comparison was made with the results for the prediction of mean test scores and scores 1 SD below the mean for the matched data in the smaller sample (i.e. excluding data on jobs from Company X), since it was these data that were probably the "cleanest". For this purpose the "averages" of the correlations of the five constructs were computed. These are given in Table 2. The average correlation for the mean test scores is .66 for the individual PAQs and .52, 53, and 51 for the three sets of cluster based predictions. For the scores 1 SD below the mean the average is .68 for the individual PAQs and .53, .55, and .52 for the clusters.

Table 2

Correlations Between Predicted and Actual Test-related Criteria for Five Constructs: Sample Exclusive of Jobs from "Company X"

Criteria and Constructs	Individual PAQs	Cluster-based predictions 20 Clusters	40 Clusters	60 Clusters	N
Mean Test Scores: Complete Sample[1]					
General Intelligence	.74***	.55***	.47**	.50**	34
Verbal Aptitude	.71***	.65***	.67***	.60***	50
Numerical Aptitude	.56***	.49***	.55***	.51***	85
Spatial Aptitude	.30*	.21	.35**	.19	50
Clerical Perception	.38*	.46**	.44**	.50***	37
1 SD Below Mean: Complete Sample[1]					
General Intelligence	.66***	.63***	.49**	.53***	33
Verbal Aptitude	.71***	.62***	.68***	.60***	50
Numerical Aptitude	.63***	.47***	.59***	.55***	64
Spatial Aptitude	.72***	.43*	.50**	.47***	30
Clerical Perception	.60*	.42	.44	.39	15
Mean Test Scores-Matched Sample[2]					
General Intelligence	.74***	.52**	.43*	.52**	33
Verbal Aptitude	.71***	.65***	.67***	.60***	50
Numerical Aptitude	.67***	.52***	.61***	.56***	64
Spatial Aptitude	.74***	.44*	.50**	.47*	26
Clerical Perception	.53*	.44	.37	.37	15
Average	.66	.52	.53	.51	
1 SD Below Mean-Matched Sample[2]					
General Intelligence	.66***	.63***	.49**	.53***	33
Verbal Aptitude	.71***	.62***	.68***	.60***	50
Numerical Aptitude	.63***	.47***	.59***	.55***	64
Spatial Aptitude	.76***	.47*	.51**	.50**	26
Clerical Perception	.60**	.42	.44	.39	15
Average	.68	.53	.55	.52	
Validity Coefficients					
General Intelligence	-.54	.37	-.14	-.14	13
Verbal Aptitude	.30	.53***	.58***	.28	36
Numerical Aptitude	.25*	.12	.48***	.40***	76
Spatial Aptitude	.26	.29	.25	.35*	43
Clerical Perception	-.02	-.03	.16	.32*	29
Valid-NonValid					
General Intelligence	.17	-[3]	-	-	13
Verbal Aptitude	-.18	-	-	-	36
Numerical Aptitude	.19	-	-	-	76
Spatial Aptitude	.76***	-	-	-	43
Clerical Perception	.51**	-	-	-	29

Table 2 (Cont.)

[1]The "complete sample" represented by this table includes all jobs for which mean test score data were available.

[2]For these analyses, only jobs for which data were available on both mean test scores and scores " 1 SD below mean" were used. This was done to eliminate any differences between the results for these two criterion indices due only to different samples.

[3]There were no analyses conducted on the "Valid-NonValid" criterion for the clusters.

*Significant, $p < .05$
**Significant, $p < .01$
***Significant, $p < .001$

It is interesting to note that, although the predictions were generally better for the individual PAQs, the predictions based on the three sets of clusters were also rather respectable. Perhaps more interesting, however, is that there are no real differences in predictive ability for the three sets of clusters. This is surprising since the clusters in the 60 cluster solution are much more homogeneous than those in the 20 cluster solution, yet predictions based on these sets of clusters are virtually identical. This raises certain questions and suggests further research on the problems of selecting the proper number of clusters from a hierarchical grouping procedure. Differences in the results obtained with different cluster solutions may not be substantially different, and perhaps practical considerations should rule in the selection of cluster solutions.

Finally, one additional potential source of contamination remaining in the data might be due to the fact that test data from different tests were combined in a "common metric". Not only could the collapsing of all the data into a common metric have an effect on the alignment of test scores, but if there were problems in predicting data on one particular test this would reduce the accuracy of predictions for a whole construct. It was not possible to deal with the question completely within the confines of the present set of data. However, it was possible to get some inkling of how well PAQ-based predictions could do in predicting test data based on individual tests. There were only four tests for which there were adequate data for such analyses, these being: the Wonderlic Personnel Test; the Employee Aptitude Survey, Verbal and Numerical Tests; and the Flanagan Industrial Tests-Arithmetic Test. The results for these tests are given in Table 3. From this table, it can be seen that the results with the first three were markedly superior to those with the Flanagan Arithmetic Test. In the case of the first three it can be seen that most of the correlations as shown in Table 3 are somewhat higher than the corresponding correlations in Table 2 (which are based on data from two or more tests converted to the common metric). One would expect such improvement since the data are based on single measuring instruments. At the same time, however, the data in Table 2 for the "matched" samples, are in themselves quite respectable, and lend credence to the notion that "pooled" data from various tests that presumably measure the same construct have substantial potential in the job component validity model.

Analyses Based on Attribute Data

As was indicated earlier in the method section, two types of data would be used in predicting aptitude requirements for jobs. In one case, job analysis data would be used (these results were presented in the previous section), while data based on the attribute ratings of PAQ elements would be used as a second source of predictor data.

Ten human attributes were selected to be used in the present study. These attributes were selected because it was felt that these attributes most closely "matched" the types of abilities covered by the five GATB constructs used in this study. For each of the attributes on

Table 3

Correlations Between Predicted and Actual Test-related Criteria for Three Constructs Measured by Four Specific Tests

Test and Criteria	Individual PAQs	Cluster-based predictions 20 Clusters	40 Clusters	60 Clusters	N
Wonderlic Personnel Test					
Mean	.81***	.58***	.48**	.53***	27
1 SD Below Mean	.75***	.72***	.55***	.62***	26
Validity Coefficient	-	-	-	-	-
Employee Aptitude Survey - Verbal					
Mean	.80***	.72***	.72***	.82***	24
1 SD Below Mean	.73***	.53**	.62***	.73***	24
Validity Coefficient	.12	.27	.26	.20	13
Employee Aptitude Survey - Numerical					
Mean	.66***	.48*	.60***	.58**	26
1 SD Below Mean	.60***	.35	.53**	.51**	26
Validity Coefficient	-.24	.23	-	.21	15
Flanagan Industrial Tests - Arithmetic					
Mean	.40	.24	.43	.17	14
1 SD Below Mean	.52	.26	.40	.19	14
Validity Coefficient	-.20	.72*	.08	.34	9

[1]Insufficient sample size to carry out analyses

*Significant, $p < .05$
**Significant, $p < .01$
***Significant, $p < .001$

Table 4

Correlations Between Predictions Based on
Attribute Data and Actual
Test-related Criterion Data
for the Total Sample

Attribute	Criterion and Construct	Correlation	N
	Mean Test Scores		
Intelligence	General Intelligence	-.07	111
Verbal Comprehension	Verbal Ability	.42**	50
Word Fluency	"	.43***	50
Oral Communication	"	.43**	50
Numerical Computation	Numerical Ability	.33***	163
Arithmetic Reasoning	"	.31***	163
Visual Perception	Spatial Ability	-.31***	125
Spatial Visualization	"	-.32***	125
Spatial Orientation	"	-.32***	125
Verbal Comprehension	Clerical Perception	.63***	38
Arithmetic Reasoning	"	.62***	38
Closure	"	.56***	38
Visual Perception	"	.42**	38
	1 SD Below Mean		
Intelligence	General Intelligence	.01	110
Verbal Comprehension	Verbal Ability	.43**	50
Work Fluency	"	.46***	50
Oral Communication	"	.44**	50
Numerical Computation	Numerical Ability	.26**	141
Arithmetic Reasoning	"	.23**	141
Visual Perception	Spatial Ability	-.27**	103
Spatial Visualization	"	-.32***	103
Spatial Orientation	"	-.28**	103
Verbal Comprehension	Clerical Perception	.51	15
Arithmetic Reasoning	"	.36	15
Closure	"	.16	15
Visual Perception	"	-.06	15

*Significant, $p < .05$
**Significant, $p < .01$
***Significant, $p < .001$

each of the jobs in the sample, predicted criterion scores were developed based upon a "cross-product sum" procedure discussed earlier in the method section (and discussed in greater detail in Shaw and McCormick, 1977). These predicted criterion scores were then correlated with the actual criterion scores for two criteria for the jobs in the sample, namely the mean test scores and the scores 1 SD below the means.

The results of this analysis are reported in Table 4. As can be seen in Table 4, the correlations between predicted and actual criteria scores were "inconsistent" across the various constructs. For example, predictions of both criteria for the General Intelligence construct were very low and non-significant ($r = -.07$ for mean test scores, and .01 for the scores 1 SD below the mean). Correlations between predicted scores and actual criteria scores on both criteria for the Spatial Aptitude construct were negative in direction ($r = -.31$). Prediction of mean test scores for Verbal Ability, Numerical Ability and Clerical Ability were somewhat more reasonable with correlations ranging from .42 to .43 for Verbal Ability , .31 to .33 for Numerical Ability, and .42 to .63 for Clerical Perception. The results for these constructs for the criterion of 1 SD below the mean were very similar to those for the mean test score criterion. The correlations ranged from .43 to .46 for Verbal Ability, .23 to .26 for Numerical Ability, and -.06 to .51 for Clerical Perception.

In general, although a number of correlations were of reasonable magnitude and did reach statistical significance, the results seem to indicate a substantial inconsistency in the predictive power of the data based on attribute ratings of the PAQ elements. Because of this inconsistency no further analyses were carried out with these data.

CONCLUSIONS

On the basis of the results of this study the following conclusions seem to be warranted regarding the use of data from the Position Analysis Questionnaire (PAQ) in the job component validity model as the basis for establishing aptitude requirements for use in personnel selection.

1. Such a model can serve to identify the aptitude tests that have substantial validity for use in personnel selection. This is done on the basis of statistical analyses of data from PAQ analyses of individual jobs. This conclusion is supported particularly by the findings regarding the predictability of mean test scores of job incumbents on various jobs, and the scores of job incumbents one standard deviation below this mean. Such predictions, originally based on test data for incumbents on the nine tests of the General Aptitude Test Battery (GATB) of the United States Employment Service, also hold up quite well with test data from various commercial tests that were considered to measure the same constructs as those measured by the GATB tests. (This analysis was based on five of the nine constructs.) Results of the predictions based on commercial tests resulting from this study are

further supported by a recent study by Cunningham et al. (1976) in which the Differential Aptitude Tests were used in much the same fashion.

2. The predictions of the validity-related criteria (those consisting of validity coefficients and those based on a "valid-nonvalid" determination) were generally not very satisfactory. These results are generally consistent with certain previous studies in which the prediction of validity coefficients also were rather poor.

3. In most cases PAQ-based predictions of test-related criteria for individual commercial tests are somewhat superior to those of criteria derived from two or more tests that have been pooled together as measures of the same construct. However, as mentioned above, the predictions of mean test scores and scores one standard deviation below the mean that are based on "pooled" test data are also quite respectable.

4. Predictions of mean test scores and scores one standard deviation below the mean that are based on job families (formed from PAQ data) are a bit lower than those based on PAQs for individual jobs. They are, however, of such magnitude as to warrant further possible research in the job component validity model. The predictions of the criterion of validity coefficients based on job family data actually tended to be slightly better than the predictions based on PAQ analyses of individual jobs.

5. Predictions based on job families resulting from the 20, 40, and 60 cluster solutions were virtually identical to each other. This is interesting since one of the problems that has often been discussed relative to the use of hierarchical grouping procedures has been the decision regarding the "optimal" cluster solution. The results from this study suggest that the number of job families used in the job component validity model may not be critical, although further research is clearly needed in this area.

6. In connection with the criteria of mean test scores and the scores one standard deviation below the mean, predictions of the test-related criteria from the attribute data are not nearly as consistent as those from the job dimension scores based on PAQ analyses. Although the predictions from the attribute data were reasonably good for certain constructs, they were very poor in the case of others. Such inconsistencies have been found in previous studies as well. It would seem, therefore, that future research relating to the use of attribute data for predicting aptitude requirements of jobs might well be focussed on the identification of the particular attributes for which such predictions can be made with reasonable validity.

7. In summary, although previous research with the use of the PAQ as the basis for establishing aptitude requirements for jobs within the job component validity framework has dealt exclusively with test data from the GATB tests, the results of this study indicate quite clearly that such data can also be used in the establishment of aptitude requirements in terms of commercial tests that presumably measure the same constructs.

References

Balma, J.J. The development of processes for indirect or synthetic validity (a symposium): 1. The concept of synthetic validity. Personnel Psychology, 1959, 12, 395-396.

Cunningham, J.W., Phillips, M.R. and Spetz, S.H. An exploratory study of a job component approach to estimating the human ability requirements of job classifications in a state competitive service system. Office of State Personnel, Department of Administration, State of North Carolina, 1976.

DeNisi, A.S., Shaw, J.B. and McCormick, E.J. Job derived selection: Preliminary Report. Prepared for the Office of Naval Research under Contract No. N00014-76-C-0274. Department of Psychological Sciences, Purdue University. Report No. 3, November 1976.

Dorcus, R.M. and Jones, M.H. Handbook of employee selection. New York: McGraw-Hill, 1950.

Jeanneret, P.R. and McCormick, E.J. The job dimensions of "worker-oriented" job variables and of their attribute profiles as based on data from the Position Analysis Questionnaire (PAQ). Prepared for the Office of Naval Research under Contract No. Nonr-1100 (28). Occupational Research Center, Department of Psychological Sciences, Purdue University. Report No. 2, January 1969.

Lawshe, C.H. What can industrial psychology do for small business? (a symposium): 2. Employee selection. Personnel Psychology, 1952, 5, 31-34.

Marquardt, L.D. The rated attribute requirements of job elements in a structured job analysis questionnaire - The Position Analysis Questionnaire (PAQ). Unpublished Master's Thesis, Purdue University, 1972.

Marquardt, L.D. The utility of job dimensions based on the Position Analysis Questionnaire in a job component validation model. Unpublished Ph. D. Thesis, Purdue University, 1974.

Marquardt, L.D. and McCormick, E.J. The dimensions underlying the job elements of the Position Analysis Questionnaire (PAQ) (Form B). Prepared for the Office of Naval Research under Contract No. N00014-67-A-0226-0016. Occupational Research Center, Department of Psychological Sciences, Purdue University. Report No. 4, June 1974.

Marquardt, L.D. and McCormick, E.J. The utility of job dimensions based on Form B of the Position Analysis Questionnaire (PAQ) in a job component validation model. Prepared for the Office of Naval Research under Contract No. N00014-67-A-0226-0016. Occupational Research Center, Department of Psychological Sciences, Purdue University. Report No. 5, July 1974.

McCormick, E.J. The application of structured job analysis information based on the Position Analysis Questionnaire (PAQ). Prepared for the Office of Naval Research under Contract No. N00014-67-A-0226-0016. Occupational Research Center, Department of Psychological Sciences, Purdue University. Report No. 9, October 1974.

McCormick, E.J., Jeanneret, P.R. and Mecham, R.C. A study of job characteristics and job dimensions as based on the Position Analysis Questionnaire (PAQ). Journal of Applied Psychology Monograph, 1972, 56, 347-368.

Mecham, R.C. Ratings of attribute requirements of job elements in a structured job-analysis format. Unpublished Master's Thesis, Purdue University, 1968.

Mecham, R.C. The synthetic prediction of personnel test requirements and job evaluation points using the Position Analysis Questionnaire (PAQ). Unpublished Ph. D. Thesis, Purdue University, 1970.

Mecham, R.C. Unpublished research report. Department of Business Administration, Utah State University, Logan, Utah. April 1977.

Mecham, R.C. and McCormick, E.J. The use of data based on the Position Analysis Questionnaire (PAQ) in developing sythetically-derived attribute requirements of jobs. Prepared for the Office of Naval Research under Contract No. Nonr-1100 (28). Occupational Research Center, Department of Psychological Sciences, Purdue University. Report No. 4, June 1969.

Shaw, J.B. and McCormick, E.J. The prediction of job ability requirements using attribute data based on the Position Analysis Questionnaire (PAQ). Prepared for the Office of Naval Research under Contract No. N00014-76-C-0274. Department of Psychological Sciences, Purdue University. Report No. 1, October 1976.

APPENDICES

APPENDIX A: Jobs for Which Test Data Were Included in the sample

APPENDIX B: Conversion of Scores on Various Personnel Tests to a Common Metric for Five Constructs

APPENDIX C: Test Publishers for Tests Used in this Study

APPENDIX D: Development of Norms

APPENDIX E: Job Dimensions Based on Principal Components Analyses of PAQ Data for 2200 Jobs

APPENDIX A

Jobs for Which Test Data Were Included in the Sample

Name	DOT	G	V	N	S	Q
** Electrical Technician	003.181	Sp_1^1		Sp_1^1	Sp_1^1	
** Misc. Subassembly	706.884	Sp_1^1		Sp_1^1	Sp_1^1	
** Cabinet Assembly	706.000	Sp_1^1		Sp_1^1	Sp_1^1	
** Keyboard Subassembly	706.884	Sp_1^1		Sp_1^1	Sp_1^1	
** Scales Inspector	710.381	Sp_1^1		Sp_1^1	Sp_1^1	
** Punchpressing	615.782	Sp_1^1		Sp_1^1	Sp_1^1	
** Instrument Repairman	710.281	Sp_1^1		Sp_1^1	Sp_1^1	
** Misc. Subassembly	706.884	Sp_1^1		Sp_1^1	Sp_1^1	
** Cabinet Assembly	706.000	Sp_1^1		Sp_1^1	Sp_1^1	
** Solder-wire	726.281	Sp_1^1		Sp_1^1	Sp_1^1	
** Keyboard Subassembly	706,884	Sp_1^1		Sp_1^1	Sp_1^1	
** Parts Inspector	223.387	Sp_1^1		Sp_1^1	Sp_1^1	
** Lathe Oper. Production (Auscran Mach. Operator)	604.885	Sp_1^1		Sp_1^1	Sp_1^1	
** Instrumental Repairman	710.281	Sp_1^1		Sp_1^1	Sp_1^1	
** Salvage Mach. Operator	638.281	Sp_1^1		Sp_1^1	Sp_1^1	
** Heat Treater (Gascarbinzingo)	504.782	Sp_1^1		Sp_1^1	Sp_1^1	
** Tool-Die Maker	610.280	Sp_1^1		Sp_1^1	Sp_1^1	
** Stock Keeper	223.381	Sp_1^1		Sp_1^1	Sp_1^1	
** Gand Grinder Operator	603.782	Sp_1^1		Sp_1^1	Sp_1^1	
** Order Checker	222.689	Sp_1^1		Sp_1^1	Sp_1^1	
** Stock Keeper	223.381	Sp_1^1		Sp_1^1	Sp_1^1	
** Order Clerk	223.387	Sp_1^1		Sp_1^1	Sp_1^1	
** Salvage Mach. Operator	638.281	Sp_1^1		Sp_1^1	Sp_1^1	
** Parts Inspector	223.387	Sp_1^1		Sp_1^1	Sp_1^1	
** Tool-Die Maker	610.280	Sp_1^1		Sp_1^1	Sp_1^1	
** Unit Checker	609.684	Sp_1^1		Sp_1^1	Sp_1^1	
** Unit Checker	609.684	Sp_1^1		Sp_1^1	Sp_1^1	
** Wirewrapper Operator	692.782	Sp_1^1		Sp_1^1	Sp_1^1	
** Analyzer Operator	249.388	Sp_1^1		Sp_1^1	Sp_1^1	
** Elec. Spec. Operator	824.281	Sp_1^1		Sp_1^1	Sp_1^1	
** Hand screw Operator	604.380	Sp_1^1		Sp_1^1	Sp_1^1	
** Heater Operator (Slngbliss Operator)	613.885	Sp_1^1		Sp_1^1	Sp_1^1	
** Milwright (Mlwrghtgrb Operator)	638.281	Sp_1^1		Sp_1^1	Sp_1^1	
** Milwright (Mlwrghtgrb Operator)	638.281	Sp_1^1		Sp_1^1	Sp_1^1	
** Milwright (Mlwrghtgrb Operator)	638.281	Sp_1^1		Sp_1^1	Sp_1^1	

APPENDIX A (Cont.)

Name	DOT	G	V	N	S	Q
** Milwright (Mlwrghtgrb Operator)	638.281	Sp^1		Sp^1	Sp^1	
** Heater Operator (Slhngbliss Operator)	613.885	Sp^1		Sp^1	Sp^1	
** Hand screw Operator	604.380	Sp^1		Sp^1	Sp^1	
** Jr. Elect. Technician	762.384	Sp^1		Sp^1	Sp^1	
** Jr. Elect. Technician	762.384	Sp^1		Sp^1	Sp^1	
** Screw Machine Set-up Man (Toollayschr Oper.)	604.428	Sp^1		Sp^1	Sp^1	
** Screw Machine Set-up Man (Toollayschr Oper.)	604.428	Sp^1		Sp^1	Sp^1	
** Turret Lathe Oper. (Toollaauscr Oper.)	604.428	Sp^1		Sp^1	Sp^1	
** Sheet Metal Mach. Oper.	804.281	Sp^1		Sp^1	Sp^1	
** Sheet Metal Mach. Oper.	804.281	Sp^1		Sp^1	Sp^1	
** Tool Maker (Spfeatlopr Oper.)	501.280	Sp^1		Sp^1	Sp^1	
** Precasting Operator	518.884	Sp^1		Sp^1	Sp^1	
** Technician Analyzer Operator	609.684	Sp^1		Sp^1	Sp^1	
** Technician Analyzer Operator	609.684	Sp^1		Sp^1	Sp^1	
** Quality Analyzer Operator	216.388	Sp^1		Sp^1	Sp^1	
** Quality Analyzer Operator	216.388	Sp^1		Sp^1	Sp^1	
Carpenter	860.281			$FIT\text{-}AR_1^1$	$FIT\text{-}AS_1^1$	
Trainman	910.364			$FIT\text{-}AR_1$	$FIT\text{-}AS_1$	
Heavy repair carman	630.281			$FIT\text{-}AR_1$	$FIT\text{-}AS_1$	
Warehouseman	929.133			$FIT\text{-}AR_1$	$FIT\text{-}AS_1$	
Agency Clerk	205.288			$FIT\text{-}AR_1$	$FIT\text{-}AS_1$	
Switchman	910.884			$FIT\text{-}AR_1$	$FIT\text{-}AS_1$	
Statement Clerk	219.388			$FIT\text{-}AR_1$	$FIT\text{-}AS_1$	
Electrician	824.281			$FIT\text{-}AR_1$	$FIT\text{-}AS_1$	
Yard Clerk	910.388			$FIT\text{-}AR_1$	$FIT\text{-}AS_1$	
Railroad Engineer	910.383			$FIT\text{-}AR_1$	$FIT\text{-}AS_1$	
Freightcar welder	812.884			$FIT\text{-}AR_1$	$FIT\text{-}AS_1$	
Carman	622.381			$FIT\text{-}AR_1$	$FIT\text{-}AS_1$	
R.R. Engineer	910.388			$FIT\text{-}AR_1$	$FIT\text{-}AS_1$	
Machinist	600.280			FIT-AR	FIT-AS	
Elec. Technician	003.181		EAS-V	EAS-N	EAS-S	
Elec. Drafter	003.281		EAS-V	EAS-N	EAS-S	
Draftsman	005.281	W				
Programmer	007.187	Adapt.				

Name	DOT	G	V	N	S	Q
Maintenance Aircraft Supervisor	621.131		EAS-V	Arith I	FIT-AS	
Gas Serviceman	637.281		EAS-V	FIT-AR		
Refrigeration Mechanic	637.381			EAS-N	EAS-S	
Maintenance Mechanic	638.281			FIT-AR		
Inspector	649.487	W		FIT-AR		
Instrument Mechanic	710.281			Arith I	FIT-AS	
Assembler	726.781			FIT-AR	FIT-AS	
Sheet Metal Worker	804.281			Arith I	FIT-AS	
Electrician	824.281			Arith I	FIT-AS	
Carpenter	860.381				FIT-AS	
**Pipe Fitter	862.381	Learn-Ab[1]				
**Pipefitter Apprentice	862.381			Arith F.[1]	MPFB[1]	
Plumber	862.381			Arith I	FIT-AS	
Truck Driver	905.883		EAS-V	FIT-AR		
Reservations Agent	912.368	W				
Packer	920.886		EAS-V		EAS-S	
Hand Packager	920.887	W				
Truckcrane Oper.	921.883		EAS-V		EAS-S	EAS-C
Laborer-Stores	922.887	W				
Medical Secretary	201.368	W				
**Bundler	221.388		PTI-V[1]	PTI-N[1]		
**Stripper	749.887		PTI-V[1]	PTI-N[1]		
**Hand Trucker	906.883		PTI-V[1]	PTI-N[1]		
**General Factory Worker	899.381		PTI-V[1]	PTI-N[1]		
**Feeder	619.886		PTI-V[1]	PTI-N[1]		
**Service Trucker	922.883		PTI-V[1]	PTI-N[1]		
**Stock Lifter	643.886			PTI-N[1]	PTI-N[1]	
**Printer Slotter	651.782			PTI-N[1]	PTI-N[1]	
**Special Officer	372.868	W[1]				
**Salesclerk	290.478			PTI-N[1]		SET-C
**Apprentice Mechanic	620.281	Learn-Ab[1]		Arith F[1]	MPFB[1]	
**Operating Trainee	550.782	Learn-Ab[1]		Arith F[1]		
**Branch Trainee	183.118	W[1]		Sp[1]		Sp[1]
**Control Equip. Mechanic	828.281			SET-N[1]	MPFB[1]	
**Welder	810.884			SET-N[1]	MPFB[1]	EAS-C

APPENDIX A (Cont.)

Name	DOT	G	V	N	S	Q
**Hand Grinder Operator	603.782	Sp_1^1		Sp_1^1	Sp_1^1	
**Drill Press Operator	606.782	Sp_1^1		Sp_1^1	Sp_1^1	
**Rivet HS	800.782	Sp_1^1		Sp_1^1	Sp_1^1	
**Springbench Operator	619.782	Sp_1^1		Sp_1^1	Sp_1^1	
**Sprinbench Operator	619.782	Sp_1^1		Sp_1^1	Sp_1^1	
**Punch Press Frm. Operator	615.782	Sp_1^1		Sp_1^1	Sp_1^1	
**Drill Press Operator	606.782	Sp_1^1		Sp_1^1	Sp_1^1	
**Drill Press Operator	606.782	Sp_1^1		Sp_1^1	Sp_1^1	
**Punch Press Frm. Operator	615.782	Sp_1^1		Sp_1^1	Sp_1^1	
**Rivet ltd. Operator	699.782	Sp_1^1		Sp_1^1	Sp_1^1	
**Drill lt. Operator	606.000	Sp_1^1		Sp_1^1	Sp_1^1	
**Gen. Foundry Worker	519.887	Sp_1^1		Sp_1^1	Sp_1^1	
**Auto. Airbrush Operator	741.884	Sp_1^1		Sp_1^1	Sp_1^1	
**Jigbore Operator	606.280	Sp_1^1		Sp_1^1	Sp_1^1	
**Drill Lt. Operator	606.000	Sp_1^1		Sp_1^1	Sp_1^1	
**Rivet Lt. Operator	699.782	Sp_1^1		Sp_1^1	Sp_1^1	
**Gauge Grinder Operator	603.885	Sp_1^1		Sp_1^1	Sp_1^1	
**Rivet HS Operator	800.782	Sp_1^1		Sp_1^1	Sp_1^1	
**Gen. Foundry Worker	519.887	Sp_1^1		Sp_1^1	Sp_1^1	
**Auto. Airbrush Operator	741.884	Sp_1^1		Sp_1^1	Sp_1^1	
**Stock Keeper	223.381	Sp_1^1		Sp_1^1	Sp_1^1	
**Jigbore Operator	606.280	Sp_1^1		Sp_1^1	Sp_1^1	
**Wire Wrapper Operator	692.782	Sp_1^1		Sp_1^1	Sp_1^1	
**Tool Planner Operator	012.188	Sp_1^1		Sp_1^1	Sp_1^1	
**Analyzer Operator	249.388	Sp_1^1		Sp_1^1	Sp_1^1	
**Elec. Spec. Operator	824.281	Sp^1		Sp^1	Sp^1	

APPENDIX A (Cont.)

Name	DOT	G	V	N	S	Q
General Clerk	209.388		EAS-V			EAS-C
Information Clerk	235.862		EAS-V	EAS-N	EAS-S	EAS-C
A/C Serviceman	637.281			EAS-N	EAS-S	
Line Repairer	821.381			EAS-N	EAS-S	
Ground Helper	821.887			EAS-N	EAS-S	
Serviceman	899.281		EAS-V	EAS-N	EAS-S	EAS-C
Maintenance Helper	899.884			EAS-N	EAS-S	
Warehouseman	922.887					EAS-C
Engineering Fieldman	003.081		EAS-V	EAS-N	EAS-S	EAS-C
Firefighter	373.884					EAS-C
Equipment Installer	822.381			EAS-N		
Excange Installer	822.381			EAS-N		
Cable Splicer	829.381			EAS-N		
** Stock Assistant				Sp[1]	Sp[1]	Sp[1]
** Typist	203.588			Sp[1]	Sp[1]	Sp[1]
** Shipping Packer	222.587			Sp[1]	Sp[1]	Sp[1]
** Shipping Checker	222.687			Sp[1]	Sp[1]	Sp[1]
** Sorter	209.688			Sp[1]	Sp[1]	Sp[1]
** Returned Goods Rec. Clerk	222.387			Sp[1]	Sp[1]	Sp[1]
** Material Handler	929.887			Sp[1]	Sp[1]	Sp[1]
** Induction Clerk	209.388			Sp[1]	Sp[1]	Sp[1]
** Bookkeeper	210.388			Sp[1]	Sp[1]	Sp[1]
** General Clerk	219.388			Sp[1]	Sp[1]	Sp[1]
** Billing Checker	209.688			Sp[1]	Sp[1]	Sp[1]
** Requisition Handler	221.388			Sp[1]	Sp[1]	Sp[1]
** Order Filler	922.887			Sp[1]	Sp[1]	Sp[1]
** Buyers Assistant	162.158			Sp[1]	Sp[1]	Sp[1]
** Receiving Checker	222.387			Sp[1]	Sp[1]	Sp[1]
** Secondary Receiver	222.387			Sp[1]	Sp[1]	SP[1]
** Industrial Truck Driver	922.833			Sp[1]	Sp[1]	Sp[1]
** Keypunch Operator	213.582			Sp[1]	Sp[1]	Sp[1]
** Calculating Mach. Operator	216.488			Sp[1]	Sp[1]	Sp[1]
** Records Clerk	222.687			Sp[1]	Sp[1]	SP[1]
** Correspondence Clerk	204.288			Sp[1]	Sp[1]	Sp[1]
** Time Keeper	219.388			Sp[1]	Sp[1]	Sp[1]
						Sp
						Sp

APPENDIX A (Cont.)

Name	DOT	G	V	N	S	Q
Industrial Engineer	012.188		EAS-V	EAS-N	EAS-S	
Actuary	020.188		EAS-V	EAS-N		EAS-C
Accountant	160.188	W	EAS-V	EAS-N	EAS-S	EAS-C
Purchasing Agent	162.150		EAS-V	EAS-N	EAS-S	EAS-C
Claims Examiner	249.268		EAS-V	EAS-N		
Underwriter	169.188	W	EAS-V	EAS-N		EAS-C
Secretary	201.368	W	EAS-V	EAS-N		
Stenographer	202.388	W	EAS-V	EAS-N		
Typist	203.588	W	EAS-V	EAS-N		
File Clerk	206.388	W				
Bank Clerk	209.388	Otis	EAS-V	FIT-AR		SET-C
Bookkeeper	210.388	Otis				
Cashier	121.368	W	EAS-V	EAS-N		EAS-C
Bank teller	212.368	W	EAS-V	FIT-AR		
Computer Operator	213.382	W				
Keypunch Operator	213.582	W	EAS-V	EAS-N	EAS-S	EAS-C
Bookkeeping Mach. Operator	215.388	W	SET-V	SET-N		SET-C
Coding Clerk	219.388			Arith I		
Accounting Clerk	219.488	Adapt.	EAS-V	EAS-N	EAS-S	EAS-C
Shipping Clerk	222.587	W				
Mail Clerk	231.588	W				
Telephone Operator	235.862	W	EAS-V	EAS-N		
Receptionist	237.368	W				
Meter Reader	239.588	W	SET-V	Arith I	EAS-S	EAS-C
Claims Adjuster	241.168	W	EAS-V	EAS-N		
Insurance Salesman	250.258	W	EAS-V	EAS-N		
Cashier Checker	299.468		EAS-V	EAS-N		EAS-C
Gate Tender	372.868	W				
Policeman	375.268	W				
** Beater Engineer	530.782	Sp_1^1		$SET\text{-}N_1^1$		
** Bleacher Man Pulp	533.782	Sp_1^1		$SET\text{-}N_1^1$		
** Fourdrinier Mach. Tender	539.782	Sp_1^1		$SET\text{-}N_1^1$		
** Recovery Operation	552.380	Sp_1^1		$SET\text{-}N_1^1$		
** Fourdrinier Operation	559.885	Sp^1		$SET\text{-}N^1$		
Machinist	600.280			FIT-AR	FIT-AS	
Inspector	619.381		SET-V	FIT-AR	FIT-AS	

Adapt. - Adaptability Test
W - Wonderlic Personnel Test
Otis - Otis Self Administering Test of Mental Ability
Learn. Ab. - Test of Learning Ability
EAS-V - Employee Aptitude Survey - Verbal
SET-V - Short Employment Tests - Verbal
PTI-V - Personnel Tests for Industry - Verbal
EAS-N - Employee Aptitude Survey - Numerical
FIT-AR - Flanagan Industrial Tests - Arithmetic
Arith I - SRA Arithmetic Index
SET-N - Short Employment Tests - Numerical
PTI-N - Personnel Tests for Industry - Numerical
Arith. F. - Arithmetic Fundamentals Test
EAS-S - Employee Aptitude Survey - Spatial
FIT-AS - Flanagan Industrial Tests - Assembly
MPFB - Revised Minnesota Paper Form Board
EAS-C - Employee Aptitude Survey - Visual Speed and Accuracy
SET-C - Short Employment Tests - Clerical
Sp - Special In-House Tests

Note: The blocks of "Special" Tests at the beginning of this list represent jobs from 2 organizations.

** PAQs obtained directly from organization. For all others, PAQs were obtained from the PAQ data bank.

[1]Test data obtained directly from organization. For all others, test data were obtained from other sources such as test manuals and journal articles.

APPENDIX B

Conversion of Scores on Various Personnel Tests to a Common Metric for Five Constructs

Construct: General Intelligence

Common Metric*	Wonderlic[1]	Adaptability[2]	Otis[3]	Learn. Ab.[4]
130	34	27	67	50
129		26		
128	33		66	49
127		25	65	
126	32	24	64	48
125				
124	31		63	
123		23	62	47
122			61	
121	30			46
120		22	60	
119				45
118	29		59	
117		21	58	
116	28			44
115			57	
114			56	43
113	27			
112			55	42
111	26	20		
110			54	41
109			53	
108	25	19		
107			52	40
106	24		51	
105		18		39
104			50	
103	23			38
102			49	
101	22		48	
100		17		37
99			47	
98	21	16	46	36
97				
96	20		45	35
95		15		
94			44	34
93	19		43	
92		14		
91	18		42	33
90				
89		13	41	32
88	17			
87			40	31
86	16	12		
85			39	30
84				

APPENDIX B

Conversion of Scores on Various
Personnel Tests to a Common Metric
for Five Constructs

Construct: General Intelligence

Common Metric*	Wonderlic[1]	Adaptability[2]	Otis[3]	Learn. Ab.[4]
83	15	11	38	
82				29
81	14		37	
80		10	36	28
79			34,35	
78	13		33	27
77		9	32	
76	12			26
75			31	26
74		8	30	
73	11			25
72			29	
71	10	7	28	24
70			27	
69			26	23
68	9		25	
67		6	24	
66	8		23	22
65			22	

* The common metric used in the conversion of test scores is based on a mean of 100 and a standard deviation of 20. This is the same scale used with the GATB tests.

[1]Wonderlic Personnel Test

[2]Adaptability Test

[3]Otis Self-Administering Test of Mental Ability

[4]Test of Learning Ability

APPENDIX B

Conversion of Scores on Various
Personnel Tests to a Common Metric
for Five Constructs

Construct: Verbal Aptitude

Common Metric*	PTI-V[1]	SET-V[2]	EAS-V[3]
130	42	47	24
129			
128	41		
127			23
126	40	46	
125			
124		45	22
123			
122	39	44	
121			21
120	38	43	
119	37		
118		42	20
117		41	
116	36		
115	35	40	19
114		39	
113	34	38	
112	33	37	18
111		36	
110	32	35	
109	31	34	17
108		33	
107	30	32	16
106		31	
105	29	30	
104	28	29	15
103		28	
102	27	27	
101	26	26	14
100	25	25	
99	24	24	
98	23	23	13
97		22	
96	22		
95	21	21	12
94	20		
93	19		
92	18	20	11
91	17	19	
90		18	
89	16	17	10
88			
87	15	16	
86	14		9
85	13	15	
84	12	14	

APPENDIX B

Conversion of Scores on Various
Personnel Tests to a Common Metric
for Five Constructs

Construct: Verbal Aptitude

Common Metric*	PTI-V[1]	SET-V[2]	EAS-V[3]
83			8
82	11		
81	10	13	
80	9		
79		12	7
78	8		
77		11	
76			6
75	7	10	
74			5
73			
72	6	9	4
71			
70			
69	5		3
68		8	
67			
66	4		2
65		7	

*The common metric used in the conversion of test scores is based on a mean of 100 and a standard deviation of 20. This is the same scale used with the GATB tests.

[1]Personnel Tests for Industry - Verbal

[2]Short Employment Tests - Verbal

[3]Employee Aptitude Survey - Verbal

APPENDIX B

Conversion of Scores on Various Personnel Tests to a Common Metric for Five Constructs

Construct: Numerical Aptitude

Common Metric*	PTI-N[1]	SET-N[2]	EAS-N[3]	Arith.I.[4]	FIT-AR[5]	Arith. Fun.[6]
130	26	54		55		42
129		53	45		41	
128		52	44	54		41
127	25	51			40	
126		50	43	53		
125		49	42		39	
124	24			52		
123		48	41		38	40
122		47	40			
121	23	46		51		
120		45	39		37	
119		44	38	50		
118	22	43			36	
117			37	49		39
116		42	36			38
115	21			48	35	37
114		41	35			
113	20	40	34	47	34	
112		39				36
111	19	38	33	46	33	
110		37	32			
109	18	36		45		
108			31		32	34,35
107		35	30	44		
106	17	34			31	
105		32,33	29	43		
104	16		28		30	33
103				42		
102		31	27			
101	15	30	26		29	
100		29		41		32
99		28	25	40	28	
98	14	27	24			
97					27	
96	13		23	39		31
95		26	22			
94	12	25		38	26	
93			21			
92		24	20	37	25	30,29
91	11	23				
90			19	36	24	
89		22	18			
88	10			35		28
87		21	17		23	
86		20	16	34		
85	9				22	27
84		19	15	33		26

APPENDIX B

Conversion of Scores on Various
Personnel Tests to a Common Metric
for Five Constructs

Construct: Numerical Aptitude

Common Metric*	PTI-N[1]	SET-N[2]	EAS-N[3]	Arith.I.[4]	FIT-AR[5]	Arith.Fun.[6]
83	8		14		21	25
82		18				
81		17	13	32		
80	7		12		20	
79		16	11	31		
78						
77	6	15	10	30	19	24
76						
75				29	18	
74	5	14	9			
73		13	8	28	17	
72						
71		12	7	27	16	23
70	4		6			
69		11		26		
68		10			15	
67	3		5	25		22
66					14	21
65		9	4	24		

* The common metric used in the conversion of test scores is based on a mean of 100 and a standard deviation of 20. This is the same scale used with the GATB tests.

[1]Personnel Tests for Industry - Numerical

[2]Short Employment Tests - Numerical

[3]Employee Aptitude Survey - Numerical

[4]Arithmetic Index

[5]Flanagan Industrial Tests - Arithmetic

[6]Arithmetic Fundamentals Test

APPENDIX B

Conversion of Scores on Various
Personnel Tests to a Common Metric
for Five Constructs

Construct: Spatial Aptitude

Common Metric*	MPFB[1]	EAS-S[2]	FIT-Ass[3]
130	59	50	
129			
128			15
127	58	49	
126			
125	57	48	
124			
123		47	14
122	56		
121		46	
120			
119	55	45	
118			
117		44	13
116	54		
115	53	43	
114			
113	52	42	
112	51	41	
111			12
110		40	
109	50		
108		39	
107	49		
106		38	11
105	48		
104		37	
103			
102	47	36	
101	46		10
100		35	
99	45		
98		34	
97			
96	44	33	
95			9
94	43	32	
93			
92		31	
91	42	30	
90	41		8
89		29	
88			
87	40	28	
86			
85	39	27	
84			7

APPENDIX B

Conversion of Scores on Various
Personnel Tests to a Common Metric
for Five Constructs

Construct: Spatial Aptitude

Common Metric*	MPFB[1]	EAS-S[2]	FIT-Ass[3]
83		26	
82	38		
81	37	25	
80			
79	36	24	6
78			
77	35	23	
76			
75	34	22	
74	33		5
73		21	
72	32		
71	31	20	
70			
69	30	19	
68			4
67	29	18	
66	28		
65		17	

* The common metric used in the conversion of test scores is based on a mean of 100 and a standard deviation of 20. This is the same scale used with the GATB tests.

[1] Revised Minnesota Paper Forms Board

[2] Employee Aptitude Survey - Spatial

[3] Flanagan Industrial Tests - Assembly

APPENDIX B

Conversion of Scores on Various
Personnel Tests to a Common Metric
for Five Constructs

Construct: Clerical Perception

Common Metric*	EAS-VSA	SET-C	Minn.
130	111	42	165
129	110	41	162
128	109		159
127	108	40	155
126	107		151
125	106		150
124	105	39	149
123	104		147
122	103	38	146
121	102	37	144
120	101		143
119	100	36	141
118	99		140
117	98		138
116	97	35	137
115	96		136
114	95	34	134
113	94		133
112	93	33	131
111	92		129
110	92	32	127
109	91		125
108	90		123
107	89	31	122
106	88		120
105	87	30	119
104	86		118
103	85		116
102	84	29	115
101	83		113
100	82	28	112
99	81		111
98	80	27	109
97	79	26	108
96	78		106
95	77		104
94	76		103
93	75		101
92	74	25	99
91	73		98
90	72	24	97
89	71		96
88	70		95
87	69	23	94
86	68		92
85	67		90
84	66	22	88

APPENDIX B

Conversion of Scores on Various
Personnel Tests to a Common Metric
for Five Constructs

Construct: Clerical Perception

Common Metric*	EAS-VSA	SET-C	Minn.
83	65		87
82	64		86
81	63		84
80	62	21	83
79	61		82
78	60		80
77	59	20	79
76	58		78
75	57	19	77
74	56		76
73	55		74
72	54	18	72
71	53		69
70	52		67
69	51	17	66
68	50		65
67	49		64
66	48	16	63
65	47		62

---

* The common metric used in the conversion of test scores is based on a mean of 100 and a standard deviation of 20. This is the same scale used with the GATB tests.

[1]Employee Aptitude Survey - Visual Speed and Accuaracy

[2]Short Employment Tests - Clerical

[3]Minnesota Clerical Test (Names Only)

APPENDIX C

Test Publishers for Tests Used in this Study

Test Publishers

1. The Psychological Corporation
   304 East 45th Street
   New York, N.Y. 10017

PTI - Personnel Tests for Industry (Verbal and Numerical)
SET - Short Employment Tests (Verbal, Numerical and Clerical)
Otis - Otis Self Administering Tests of Mental Ability
Minn.- Minnesota Clerical Test
MPFB - Revised Minnesota Paper Form Board

2. Richardson, Bellows, Henry & Co., Inc.
   1 West 57th Street
   New York, N.Y. 10019

Learn. Ab. - Test of Learning Ability
Arith. Fund - Arithmetic Fundamentals Test

3. Science Research Associates, Inc.
   259 East Erie Street
   Chicago, Illinois 60611

Adaptability - Adaptability Test
Arith. I - SRA Arithmetic Index
FIT - Flanagan Industrial Tests (Arithmetic and Assembly)

4. Western Psychological Services
   4311 Wilshire Boulevard, Suite 6000
   Los Angeles, California 90005

EAS - Employee Aptitude Survey (Verbal, Numerical, Spatial and Visual Speed and Accuracy)

5. E.F. Wonderlic & Associates, Inc.
   P.O. Box 7
   Northfield, Illinois 60093

Wonderlic - Wonderlic Personnel Test

APPENDIX D

Development of Norms

In order to carry out this study, it was necessary to have all test data in some common framework - this is, all test scores had to be expressed in terms of some common scale. In order to do this, it would have been desirable to have data on all the tests used in this study for the same population. This was clearly not possible. Therefore, some alternative strategy had to be formulated. Since the tests of the General Aptitude Test Battery (GATB) of the United States Employment Service were used as the criterion tests in other studies involving the PAQ in a job component validity model (Mecham and McCormick, 1969; Marquardt and McCormick, 1973), it was decided that the norms for the GATB would be utilized as the basic framework. The GATB tests are reported in standard score form, with a mean of 100 and a standard deviation of 20, these values being derived from test data on over 20,000 people collected by the United States Employment Service.

The major problem, however, was with the other tests that would be used in this study. Although it was not very difficult to assign any given test to an appropriate construct, since the "constructs" utilized in this study were of such a broad nature (for example, it seems obvious that the Short Employment Test of Verbal Ability should be classified as a "Verbal Aptitude" test), there is no body of data indicating the norms for these tests on a "general" population. Not only were the different tests used with different populations, but for most tests there was not a single population that could be considered as a "general working population" for which norms were supplied. Since that is basically what the GATB norms are based on, it seemed desirable to have all other norms based on the same kind of population.

The first problem, then, was to construct general norms for each of the different tests. The seriousness of this problem varied for the different tests. For example, for the Employee Aptitude Survey Tests, norms are provided for a general working population, and so these norms were used. For the Otis Test of Mental Ability, norms are provided for a general population, but these norms are given separately for males and females, and so they had to be consolidated into a single set of norms. For the various tests published by the Psychological Corporation (viz. The Short Employment Tests and The Personnel Tests for Industry), no general norms are provided. Rather, there are norms provided for separate occupational groups. In general, the number of occupational groups for which such norms were provided were too numerous to be reasonably consolidated, so these norms were sampled. That is, a number of groups which seemed to have "high" norms were combined with a number of groups which seemed to have "low" norms, yielding a single set of norms which it was felt provided a fair representation of a norm for a "general" population.

Thus, for each test a single set of norms was constructed, recognizing that the populations deemed "general" were different for each test.

Again, there was no way to avoid this lack of a single "general" population for whom scores were known on all tests used. The test scores which were obtained from either the organizations involved in the study, or any of the other methods discussed earlier, for each job, were then standardized on the general norms established for the corresponding GATB test. This resulted in a standard score for each test, for the incumbents on each job, reflecting where the mean for incumbents on that job fell on the particular construct relative to all other jobs.

The problem still remained of converting all these scores to some common metric. As was pointed out above, the GATB norms were to be used as the framework for this common metric. Since one set of standard scores is always directly convertible to any other set of standard scores, the scores for each job were then converted into standard scores with a mean of 100 and a standard deviation of 20. For example, if the mean score for a sample of plumbers happened to be 48 on the Revised Minnesota Paper Form Board, and this was found to be equal to a standard score of .50 based on the general population norms constructed for that test, conversion to the GATB norms was simply a matter of multiplying the GATB standard deviation of 20 by .5, (10), and adding this this to the GATB norm mean of 100 (since the standard score was positive), yielding a GATB standard score of 110. This process was repeated for each job and each test so that the final product was a continuum for each "construct," with the mean scores of incumbents on the various jobs being assigned positions on this continuum based on standard scores with a mean of 100 and a standard deviation of 20. It was these converted scores that were used as the criterion values of "mean test scores" used in this study. Thus, since the PAQ based predictions are in terms of the GATB tests, and the criterion tests scores for the various jobs were in GATB standard score terms, mean test score values for the two could be directly compared for any job. A somewhat similar procedure was used in deriving the prediction cut-off score criterion values, which were one standard deviation below the mean of the scores of incumbents on the individual jobs.

APPENDIX E

Job Dimensions Based on Principal Components Analyses of PAQ Data for 2200 Jobs

No.	Technical title	Operational title
	Division Dimensions	
	Division 1: Information Input	
1.	Perceptual interpretation	Interpreting what is sensed
2.	Input from representational sources	Using various sources of information
3.	Visual input from devices/materials	Watching devices/materials for information
4.	Evaluating/judging sensory input	Evaluating/judging what is sensed
5.	Environmental awareness	Being aware of environmental conditions
6.	Use of various senses	Using various senses
	Division 2: Mental Processes	
7.	Decision making	Making decisions
8.	Information processing	Processing information
	Division 3: Work Output	
9.	Using machines/tools/ equipment	Using machines/tools/ equipment
10.	General body vs. sedentary activities	Performing activities requiring general body movements
11.	Control and related physical coordination	Controlling machines/ processes
12.	Skilled/technical activities	Performing skilled/technical activities
13.	Controlled manual/related activities	Performing controlled manual/related activities
14.	Use of miscellaneous equipment/devices	Using miscellaneous equipment/ devices

APPENDIX E (Cont.)

Job Dimensions Based on Principal Components
Analyses of PAQ Data for 2200 Jobs

No.	Technical title	Operational title
15.	Handling/manipulating/ related activities	Performing handling/related manual activities
16.	Physical coordination	General physical coordination
Division 4: Relationships With Other Persons		
17.	Interchange of judgmental/ related information	Communicating judgments/ related information
18.	General personal contact	Engaging in general personal contacts
19.	Supervisory/coordination/ related activities	Performing supervisory/ coordination/related activities
20.	Job-related communications	Exchanging job-related information
21.	Public/related personal contacts	Public/related personal contacts
Division 5: Job Context		
22.	Potentially stressful/ unpleasant environment	Being in a stressful/ unpleasant environment
23.	Personally demanding situations	Engaging in personally demanding situations
24.	Potentially hazardous job situations	Being in hazardous job situations
Division 6: Other Job Characteristics		
25.	Non-typical vs. typical day work schedule	Working non-typical vs. day schedule
26.	Businesslike situations	Working in businesslike situations
27.	Optional vs. specified apparel	Wearing optional vs. specified apparel
28.	Variable vs. salary compensation	Being paid on a variable vs. salary basis

APPENDIX E (Cont.)

Job Dimensions Based on Principal Components
Analyses of PAQ Data for 2200 Jobs

No.	Technical title	Operational title
29.	Regular vs. irregular work schedule	Working on a regular vs. irregular schedule
30.	Job demanding responsibilities	Working under job-demanding circumstances
31.	Structured vs. unstructured job activities	Performing structured vs. unstructured work
32.	Vigilant/discriminating work activities	Being alert to changing conditions
	Overall Dimensions	
33.	Decision/communication/ general responsibilities	Having decision, communicating, and general responsibilities
34.	Machine/equipment operation	Operating machines/equipment
35.	Clerical/related activities	Performing clerical/ related activities
36.	Technical/related activities	Performing technical/ related activities
37.	Service/related activities	Performing service/related activities
38.	Regular day schedule vs. other work schedules	Working regular day vs. other work schedules
39.	Routine/repetitive work activities	Performing routine/ repetitive activities
40.	Environmental awareness	Being aware of work environment
41.	General physical activities	Engaging in physical activities
42.	Supervising/coordinating other personnel	Supervising/coordinating other personnel
43.	Public/customer/related contact activities	Public/customer/related contacts
44.	Working in physically unpleasant/ hazardous/ demanding environment	Working in an unpleasant/ hazardous/demanding/environment

APPENDIX E (Cont.)

Job Dimensions Based on Principal Components Analyses of PAQ Data for 2200 Jobs

No.	Technical title	Operational title
45.	Unnamed	Unnamed

Source: Mecham, February 1977.

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